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By William M. Sheehan*

Introduction

Air transportation in the United States has expanded at an extraordinary rate, without any service having been provided for handling heavy, bulky goods cheaply. The fact that the shipment of goods, large or small, has contributed least to the growth of airline operations[1] suggests that this subject is not receiving all the attention it merits. It may be asked, therefore, whether the development of a profitable, unsubsidized air freight service at the present time is feasible.

The type of goods specified as "air freight" herein may be distinguished in general from air express shipments by their greater weight and size and lesser intrinsic value. An air freight service would, in fact, supplement rather than compete with the present air express service. Although reference will be made primarily to the possibility of freight service along the present air mail route between New York and San Francisco, the scope of this investigation includes any two remote points in the United States connected by a government maintained airway, the termini and intermediate stations of which are sufficiently important to justify such a service.

There has been much discussion of late about the importance of aviation to the national welfare. It is generally agreed that "hardly another civil activity of our people bears such a direct and intimate relation to the national security as does civil aviation."[2] Yet the question of whether or not our air transport industry can be expanded on a sound basis to facilitate shipments of heavy, bulky commodities is almost entirely neglected. Involvement in a major war would make it necessary for the United States to increase suddenly much of its industrial activity. In such a case, the need of a well-functioning air freight system might be shockingly apparent. Quick and efficient movement of tools and supplies from one industrial center to another is just as imperative as the defence of our shores by battleships or the access to raw materials

* The author wishes to express appreciation to Dr. Wayne L. McMillen of American Airlines, Inc., Chicago, for his helpful comments and suggestions.

1. Express pound-mileage flown in 1938 was approximately one-third that of mail and one twenty-fourth that of passenger traffic (allowing 200 pounds for each passenger and baggage). Civil Aeronautics Authority.

2. President Roosevelt, address to National Aviation Forum, January, 1939.

by a strong merchant marine. Especially in the production of aircraft, necessitating the assembly of engines, propellers and accessories from every corner of this vast country, would this need be urgent. During World War I a 600 per cent annual loss of first line airplanes was suffered on each side. In World War II the rate of loss may be even greater. With the present unsettled state of world affairs it can hardly be judged too soon for the United States to build up a dependable commercial air freight service.

Even without the consideration of war an efficient and profitable air freight system would be a most important contribution to the national welfare. Many economists assert that the United States sadly needs important new industries and that her prime problems of unemployment and lagging trade would be largely solved by expanding her frontiers in some new direction.[3] By developing the one untried branch of airline enterprise whose quickening influence would most readily be felt throughout industry and trade, a step toward the solution of these economic problems could indeed be made.

Yet, persuasive as such considerations of national welfare may be, the question remains, is the development of an air freight service on a profitable, unsubsidized basis at the present time feasible? The subject will be considered in four parts: first, the demand for an air freight service; second, the cost thereof; third, a suitable rate structure and the resulting profits; and fourth, routes and schedules.

I. Demand

The enormous quantities of goods that move in the United States every day by trains, trucks and boats indicate that a large latent demand exists for any rapid, moderately-priced freight service. Speed perhaps more than any other attribute characterizes our times, and the quickest kind of transportation ordinarily commands an advantage. The need for an air freight service will be considered both quantitatively and qualitatively, that is, with reference to the amount of traffic which may be expected and to the nature of that traffic.

Amount of Traffic

Only recently have goods begun to move by air. In this country practically all such traffic goes as express on the regular passenger and mail schedules of the airlines. The following table shows that the increase of air express traffic during the past ten years has been

3. Alvin H. Hansen, in a paper entitled "A Rational Program for Economic Recovery" presented at the first session of the Economic Advisory Council of the National Industrial Conference Board, February 23, 1939.

extremely rapid and augurs well for the development of a similar air freight service.

TABLE 1

DOMESTIC AIR EXPRESS TRAFFIC[4]

Year	*Volume*
1929	249,634 lbs.
1930	359,523 lbs.
1931	788,059 lbs.
1932	1,033,970 lbs.
1933	1,510,215 lbs.
1934	2,133,191 lbs.
1935	3,822,397 lbs.
1936	6,958,777 lbs.
1937	7,127,369 lbs.
1938	7,335,967 lbs.

In an exhaustive study[5] of the nature of air express operations in 1934, it was shown that traffic was confined almost entirely to shipments of small size and high value and to objects required in emergencies. It was further shown that three quarters of all shipments weighed five pounds or less, while the average weight of shipment was six and a half pounds. The most recent statistics indicate that these characteristics have altered very little. With a tariff of nearly one dollar a pound for distances greater than 2,349 miles, where the lowest pound-mile rates are offered,[6] only commodities urgently needed, of insignificant weight or of great value will continue to be attracted to Air Express. Perhaps the most remarkable feature about the growth of air express traffic is that it has been achieved in the face of high rates. If six or seven million pounds of light, high-value goods move each year under present rates of Air Express, one may expect many more pounds of heavier, less valuable goods to be attracted with an appreciably lower air freight tariff.

From time to time studies have been made of the increase in shipments of goods by air to be expected with given reductions of rates. One of the most reliable of these[7] concludes that a large increase in traffic may be expected with, and only with, a substantial decrease in rates. With respect to this study, an authoritative comment follows:

"The present transcontinental air express rate is about eight times the rail express rate. It has been estimated that a decrease in this rate to about

4. Civil Aeronautics Authority statistics.
5. W. L. McMillen, "Air Express in the United States," *Journal of Land and Public Utility Economics.* August-November, 1935 and February, 1936.
6. *Cf.* Appendix II.
7. Unpublished paper of J. F. Scheetz, "Investigation of Air Express Possibilities," quoted in McMillen, *op. cit.*

four times the rail rate would increase the volume about one hundred per cent, while a decrease to three times the rail rate would increase the volume five hundred per cent. It has also been estimated that at an average rate of 30 cents per ton-mile the volume of air express would be nearly 9,000,000 ton-miles annually or nearly 20 times the present volume. These estimates seem to be conservative."[8]

Another estimate, made in 1932, indicates that with lower rates, air carriers might get a large amount of commodity transportation business from trains and trucks. This opinion states:

"Very roughly, the present express business done in the United States on railroads and highway vehicles totals about 800,000,000 ton-miles. I believe that, at rates which should be attainable within the next six or eight years, about 3 per cent of it can be swung over into the air, or a total of about 25,000,000 ton-miles. It ought to be possible to attract an equal amount of traffic from the fast freight services which many railroads are now running between important centers."[9]

This would amount to a twenty-five fold increase in the 2,000,000 ton-miles of commodity business flown at present.

These figures, incidentally, demonstrate that great as the expansion of air freight traffic may be, the loss thereof to trucks and trains would prove relatively insignificant. Nor need one fear appreciable loss of express traffic by the existing airlines. As will be shown subsequently, slower schedules and rates partial to long and heavy hauls will not only create new business for air freight, but will tend to prevent loss of present express business to the airlines. In fact, the existing companies may have all they can do to accommodate their faster moving and rapidly expanding passenger, mail and express traffic. It is possible that in the near future all first class United States mail will be forwarded on regular air mail schedules, as is now being done in many European countries, including Great Britain.

In view of the foregoing estimates it is reasonable to believe that a great quantity of air freight business is awaiting development, provided a way can be found to offer rates appreciably lower than those now in effect for air express. Subsequently the practicability of an average rate of 30 cents a ton-mile, mentioned above as prerequisite to such development, will be examined.

Nature of Traffic

Not only the amount but also the nature of traffic to be expected with air freight should be considered. Reference has already

8. Editorial by F. D. Fagg, Jr., 6 JOURNAL OF AIR LAW 424, July, 1935.
9. E. P. Warner, *Aviation*, August, 1932, p. 343.

been made to one aspect of this subject, viz., that air freight shipments should not be expected to include small, light packages of high value. These could continue to stand the higher cost of express service, and should be encouraged to do so by a tariff more favorable to heavy and bulky shipments.[10] Individual air freight shipments may be expected to weigh from about ten pounds to the limit of the aircraft's capacity, which would be in the thousands of pounds,[11] with the average weight fairly close to the former figure.

Another and more difficult aspect of the nature of traffic is the kind of goods likely to constitute air freight shipments. The service to be offered by air freight, from the point of view of both speed and rates, would be intermediate in character to the present services of rail and air express. Consequently, a freight airline may be expected to carry the same general types of goods now handled by one or both of these services. In the following paragraphs analyses of rail express and air express traffic will be shown, after which an attempt will be made to determine upon which of the specified classes of goods air freight would be most likely to draw for its traffic.

The following table lists the main classes of goods moved by rail express:

TABLE 2

GOODS MOVED BY RAIL EXPRESS[12]

Newspapers, Printing and Advertising Materials
Machines, Parts and Supplies
Valuables
Photographic Material
Dry Goods (half the volume)
Cut Flowers
Perishable Foods
Laundry
Livestock
Miscellaneous Items

An analysis of goods moved by air express is, perhaps, an even better indicator of the kinds of commodities likely to constitute air freight traffic. This appears below in Table 3, which adheres to the same classifications as Table 2. It is based upon a nation-wide survey of the air express business in April, 1937, and shows what percentage of the total number of shipments each of the above classifications represents.

10. *Cf.* Rates, p. 483.
11. Shipments of machine parts weighing 500 or 600 lbs. are already made occasionally by Air Express.
12. F. Quindry, 4 JOURNAL OF AIR LAW 145, April, 1933.

TABLE 3

GOODS MOVED BY AIR EXPRESS[13]
(In percentage of total volume)

1.	*Newspapers, Printing and Advertising Materials*..... Newspapers and Racing Forms (7.96%); Electros, Matrices, Printers' Materials (11.22%); Advertising Matter (4.00%); Transcription Records and Radio Material (2.74%).	25.92%
2.	*Machines, Parts and Supplies*..... Steel Products (5.17%); Auto and Rubber Accessories (5.05%); Aviation Supplies (.96%); Oil Company Supplies (.70%); Electrical Products, Telephone and Refrigerator Parts (2.56%); Optical and Camera Supplies (1.80%); Medical Supplies (1.71%).	17.95%
3.	*Valuables* ..... Valuable Bank Papers (5.45%); Ship Clearance Papers (3.40%); Investment Bankers' Prospectuses (1.42%); Jewelry (2.14%); Gold (.08%); Currency (.03%); Personal Shipments (5.25%).	17.77%
4.	*Photographic Material* ..... Motion Picture Films (5.21%); News Photos (9.21%).	14.42%
5.	*Dry Goods* ..... Clothing (8.25%); Millinery, Shoes and Fine Fabrics (5.22%).	13.47%
6.	*Cut Flowers*	1.84%
7.	*Perishable Foods*	1.34%
8.	*Laundry*	Negligible
9.	*Livestock*	Negligible
10.	*Miscellaneous Items* ..... Products of Local Industries (2.36%); Liquor (.52%); All Other Items (4.41%).	7.29%
	Total	100.00%

Most of the classes of shipments represented in the above two tables may be expected to move regularly by air freight in substantial volume. But goods that are extremely heavy, bulky or of very low value per unit weight are not likely to be attracted away from the rails. And small items of great value or that are urgently needed should continue to go by fast air express. Applying these general principles to the various classes of Tables 2 and 3 suggests the following comments:

1. *Newspapers, Printing and Advertising Materials.* These articles are especially suitable for air transportation because they provide a large and fairly regular demand. Yet the preponderance

13. Information supplied by the Air Express Division of the Railway Express Agency in letter of January 17, 1939. Weight and revenue statistics not available.

of these shipments in present air express traffic, as shown in Table 3, does not necessarily indicate that this class of commodity will predominate in an air freight business. The large individual newspaper shipments now carried by air express are most practical on comparatively short hauls, and there slow flying air freight could not offer an appreciable time advantage over surface transportation. Radio, telegraph and teletype services make it increasingly unlikely that, even with lower air freight rates, many news publications would be transported regularly on long hauls. The Pacific Coast Edition of *The Wall Street Journal,* for instance, is printed separately from the New York edition, in the far West. *Time,* Inc., which at present prints its weekly news magazine in Chicago and distributes from there, would rather set up printing equipment in California and make western distribution than pay as little as 30 cents a ton-mile to achieve earlier delivery by air freight.[14]

2. *Machines, Parts and Supplies.* Shipments of this character are often needed in a hurry and in this respect they are well suited to air transportation. Since they are usually heavy, the cost of sending them by air at present is considerable. Nevertheless they constitute, as shown in Table 3, one of the major air express classifications. It would seem entirely likely that a long-distance freight airline which connects a number of large industrial communities would find this one of its most important types of shipment. An air freight line could build up its activity in this category by enabling all sorts of businesses to operate with reduced inventory and hence reduced overhead. In recent times, many enterprises, especially chain store companies, have found it advantageous to operate with greater turnover in order to keep down inventory taxes and increase return on invested capital. Rapid turnover also effects closer attention to customer wants and reduces style losses. The great number of business enterprises which now use rail express for the above purposes might find the use of air freight a further step in the direction of economies. Indicative of the promising and profitable nature of this particular sort of traffic is the fact that private airplane operators have already begun to carry supplies for various industrial concerns between specified points. It would hardly seem likely that such operators could with sound operating practices compete successfully against a common carrier freight airline. Yet if they are allowed to develop unchecked by regular airline competition, they may some day constitute the same sort

14. Letter from N. L. Wallace, Production Manager of *Time,* Inc., who points out that more than half of *Time's* circulation must go through the U. S. Post Office for delivery anyway.

of threat to air freight common carriers as the contract carrier trucks have been to the railroads of the country.

3. *Valuables.* These shipments are almost invariably of light weight, small size and great value either intrinsically or to the shipper. Cost of transportation is not of primary importance when articles of great value must be shipped in a hurry. They are much better suited to air express than to air freight.

4. *Photographic Material.* Because of small weight and the need of rapid shipment, these articles may be expected to move by air express rather than by air freight.

5. *Dry Goods.* This class of commodity constitutes, as indicated by Tables 2 and 3, approximately one-half of rail express and one-eighth of air express traffic today. With rates closer to those of rail express, a much larger proportion of these articles would be attracted to air freight than has been moved by air express. Merchants desire speedy air shipment of various expensive styled goods, such as millinery, furs, dresses, gowns and shoes, because: 1) last minute re-ordering during special sales and holiday seasons is made possible; 2) displays can be made simultaneously with those in New York; and 3) goods received overnight have enhanced sales appeal.[15] Considering the frequent changes in feminine styles, the sudden sallies on dealers' stocks and the desirability of low inventories, a low-cost air freight service should carry a very appreciable amount of dry goods.

6. *Cut Flowers.* The shipment of cut flowers from west to east and from south to north offers inviting possibilities. California orchids and gardenias are shipped by rail to New York regularly, where they bring much higher prices because they are hardier and larger than the eastern hot-house variety. The San Francisco region alone shipped east more than 1,500 carloads of roses, orchids, carnations, gardenias, camellias, chrysanthemums and lilies, worth $3,000,000, in 1937.[16] Shipments of orchids and gardenias by air express from the same region frequently average 1,500 pounds a week, with well over a ton before Easter, Mothers' Day and other special times.[17] Much of this highly perishable traffic which now crosses the country by rail in four or five days could be attracted to a faster and but moderately more expensive air freight service.

7. *Perishable Foods.* Air express has been able to gain only a small amount of this traffic from rail express. With lower rates

15. Sampling survey, reported in *Express Messenger,* April, 1938. Pictures in *Life,* August 9, 1937, illustrate the third point, showing dress costing $25-$29 originally, but, after three weeks, $8.90.
16. *Express Messenger,* April, 1938.
17. *Ibid.,* April and June, 1938.

air freight should be able to win more of it, especially of the shipment of foods having high value per unit weight, e.g., tropical fruits, tree-ripened figs, strawberries, asparagus and artichokes. Ripe-picked fruits and vegetables usually have better flavor than produce picked green so that it may ship well, and accordingly command better prices. Shipments of seasonal fruits and vegetables during times of crop shortage, as well as the first of each new crop delivered to the eastern market, frequently bring prices high enough to justify the use of a moderate-cost air freight service.[18] Many fruits and vegetables grown the year 'round in localities such as Imperial Valley, California, could be brought to the northern and eastern markets while they are still "out of season," yet remain outside the extreme luxury class where the present high cost of air transportation places them. Oysters, lobsters and fresh fish are fairly common shipments by air today, as much as a ton and a half occasionally constituting a single shipment.[19] Movement of perishable foods would be largely from west to east and from south to north, tending to offset the stronger movement of clothing and industrial products in the opposite directions. But before there can be regular, large-scale transportation of perishable foods by air, it will be necessary to solve the problem of economical temperature control in aircraft.

8. *Laundry.* This is essentially a short-haul, bulky commodity; it is safe to presume that not much of it would move by air freight.

9. *Livestock.* Although some shipments of animals for breeding purposes, pets and baby chicks are made by air express and would more likely go by air freight, the railroads would probably continue to hold almost all of this type of shipment.

10. *Miscellaneous Items.* This classification includes items not covered by the foregoing titles, such as drugs, chemicals, compressed gasses, burial cases, musical instruments, sporting goods, dyes and seeds.

A summary of the foregoing comments concerning the probable nature of air freight shipments, based upon existing rail express and air express traffic, appears in the following table:

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18. For example, just before Christmas, 1938 California peas-in-the-pod sold for 28c a lb. in New York City and might have been rushed there by air freight, had it been available, according to several leading produce shippers in San Francisco.

19. *Express Messenger,* November, 1938.

TABLE 4

CLASSES OF GOODS LIKELY TO BE MOVED BY AIR FREIGHT

Dry Goods
Machines, Parts and Supplies
Newspapers, Printing and Advertising Materials
Perishable Foods
Cut Flowers
Miscellaneous Items

Although estimates as to the relative importance of each of the classes listed in Table 4 seem of questionable value, the opinion, based upon the foregoing analysis, may be ventured that the various classes are listed above in order of their probable frequence of shipment.

Doubtlessly some of the airlines as well as other interested organizations have from time to time made detailed inquiries into the various aspects of freight traffic demand touched upon above. But nothing authoritative has been published in the last three years. An investigation, based upon an exhaustive survey of present-day trade requirements and opinions, would contribute materially to our knowledge of the exact amount and nature of air freight traffic demand. Even without such detailed information, it seems safe to conclude that a very large demand for this type of service is latent today.

II. COSTS

The necessary expenses of an air freight service depend upon such factors as extent of route, number of schedules and type of equipment used. They may be examined under two headings, *capital costs* and *operating costs*. The former will be illustrated briefly, the latter more fully, with reference to a service over a transcontinental route.

In determining the capital and operating costs of a prospective air freight service, one of the existing transcontinental airlines, American Airlines, Inc., Transcontinental and Western Air, Inc., or United Air Lines, makes a useful object of study. The last named, a well-equipped and conservatively managed company, has been chosen for examination largely because of the availability of necessary data. A coast-to-coast service is selected because the time-saving advantage of the airplane over its closest competitor, the railroad, is greater on long than on short hauls. Time saved over train travel on a transcontinental flight may be measured in days, whereas on short stops, after allowing for the usual remote loca-

tion of airports, the advantage is only a matter of hours. Incidentally, the route of a long distance service can be selected so as to include those close-by industrial centers between which, with any time-saving at all, air traffic would be heavy. It seems likely that the first successful freight service, like the pioneer airmail line, will be over a transcontinental route such as that of United Air Lines.

It should be noted that this study supposes either: 1) a small number of exclusively freight schedules operated as a separate division of an existing major airline, or 2) a large number of exclusively freight schedules operated by a new airline. In either case, total operations are presumed to be on the same scale as those of United Air Lines in 1936, upon which the subsequent examination of operating costs is based. Since unit ground operating costs tend to decline with increased operations, i. e., number of revenue-miles flown, it is important to keep in mind the total operations involved. Whether regarded as those of an airline devoted entirely to freight or as a division of an airline offering both passenger and freight services, freight operations should be held responsible for all their own capital and operating expenses, both flying and ground, and will be so treated in the following analysis.

Before examining United Air Lines' cost figures, it should be determined whether it is more advisable to plan development of a freight service with large twin-engined monoplanes such as their Douglas DC-3's, or with smaller ones like their Boeing 247-D's. While the former, because of a much larger maximum payload,[20] is cheaper to operate per ton-mile of capacity than the latter, the Boeing 247-D has been selected herein as the type of made-over freighter most likely to be used during the next few years, for the following reasons: 1) The Boeing 247-D is now rather obsolete for passenger service requirements and should be generally available, in good condition.[21] Whether manufacturers can continue to keep the airlines supplied with sufficient high-speed tonnage to free any appreciable number of Douglas DC-3 aircraft for freight work during the next few years is not entirely clear, in view of rapidly mounting rearmament orders and steadily increasing passenger, mail and express traffic. 2) Until the existence of a large regular demand for air freight service is definitely established, it seems more advisable to use equipment which, by virtue of a smaller load capacity, could more readily be filled. If an air freight business can be

20. Approximate maximum payload of Douglas DC-3 is 6,615 pounds; of Boeing 247-D is 2,740 pounds.

21. Thus U.A.L. has during the past few years retired by lease or sale at approximately half cost most of its original fleet of about 55 Boeing 247-D's, to make way for 35 Douglas DC-3's. The expected purchase of Douglas DC-4's, Boeing Stratoliners and Douglas DC-5's by this and other airlines will tend to make more obsolescent and hence even more available Boeing 247-D's, Lockheed Electras and Douglas DC-2's.

shown likely to succeed with Boeing 247-D flying equipment, then use of the more efficient Douglas DC-3's or of large specially designed air-freighters would make profitable operations even more certain. 3) Since the original purchase price of the Boeing 247-D has been largely written off, the amount of capital investment in this kind of equipment, whether by existing or new airline, should be much less than would be necessary for the Douglas DC-3. No matter how complete one's confidence in a new untried enterprise, discretion prescribes the smallest investment practicable.

Capital Costs

If an *existing* transcontinental airline were to operate as a separate service a small number of exclusively freight schedules, it would probably have little need for new capital investment. Obsolete yet structurally sound airplanes, engines and other equipment, which had been written off in whole or in part, could be allocated to a separate freight division. An increased burden would be placed upon shop and hangar equipment, but probably not enough to interfere with passenger, mail and express business or to necessitate large additions to existing capital equipment.

A new enterprise, on the other hand, organized to operate a large number of exclusively freight schedules over one of the present transcontinental airways, would require a considerable capital outlay. Yet even this cost should amount to less than the original capital investment of comparable existing passenger airlines. Use of outmoded but structurally sound passenger equipment and of less expensive station facilities and hangar locations, would result in smaller investment expense. Operating along government-equipped and maintained airways and leasing, rather than purchasing, property wherever possible would eliminate some of the airway equipment cost with which existing airlines have been burdened in the past.

The total value of real property and equipment owned and used on United Air Lines' coast-to-coast route, as of June 30, 1938, was $7,471,392.44.[22] A *very rough approximation* of the rock-bottom investment necessary for a new transcontinental air freight business, on as large a scale of operations as that of United Air Lines in 1936, may be derived, as shown in Table 5, by making the following adjustments in United Air Lines' itemized list of properties and equipment. 1) 36 Boeing 247-D airplanes[23] at half orig-

22. Petition of U.A.L. filed with C.A.A., October 27, 1938.

23. It will be shown subsequently that an airplane in freight service would have a very low average flying speed and would consequently require less frequent maintenance and overhaul attention. Accordingly the Boeing 247-D in freight operation should average more revenue-miles of services per day

inal value and 36 spare engines at full value are substituted for figures given for airplanes and engines. 2) A proportionate adjustment is made in the figure for airplane radio equipment. 3) Elimination is made of: all items of capital cost which might be leased rather than bought, such as buildings and hangars, roads, walks and runways; improvements to leased premises; land and assets under construction. 4) A moderate amount is added for organization and developmental expense and for working capital.[24]

TABLE 5

ESTIMATED CAPITAL COSTS OF A NEW TRANSCONTINENTAL FREIGHT AIRLINE

Item	*Value*
36 Boeing 247-D Airplanes at $35,000	$1,260,000
36 Spare P & W S1H1G Engines at $9,000	324,000
36 Airplane Radio Equipment at $4,680	168,480
Shop Equipment	117,660
Airways Communication Equipment	125,301
Hangar Equipment	170,434
Motorized Vehicles	74,124
Fuel Distribution Equipment	46,409
Furniture and Fixtures	138,500
Field Lighting Equipment	30,191
Miscellaneous Ground Equipment	9,966
Organization, Developmental Expense and Working Capital	500,000
Total	$2,965,065

It should be stressed that the above figure of approximately three million dollars is a necessarily rough estimate of the total capital that a new enterprise would require to develop a transcontinental freight service on a scale as large as that of United Air Lines' 1936 passenger, mail and express business. Although initial operations would probably not require the outlay of this entire amount, it would seem advisable for competitive reasons for a new enterprise to be prepared to expend this much ultimately. Use of more efficient obsolete passenger equipment or of specially designed aircraft would, of course, alter these investment requirements considerably.

than as a passenger airplane. A 50 per cent greater average daily mileage, or 1,422 revenue-miles a day, is assumed, which indicates 36 Boeing 247-D's in freight service would fly the same mileage as U.A.L.'s 48 Boeing 247-D's actually flew in 1936.

24. Assuming that the Railway Express Agency is responsible for pick-up and delivery of freight as it is now for air express shipments, there will not be the same great need of working capital that passenger airlines have experienced.

Operating Costs

The very heart of the question of air freight's feasibility is operating expense. As seen in the consideration of demand, an air freight business is likely to succeed only if rates are offered which are much less than those in effect for air express today. Such rates cannot be offered unless operating costs are low enough to permit them. Operating costs will be considered under the following subheadings: A. *cost of present airline operation;* B. *economies of freight service operation;* C. *increases in payload of freight service operation;* D. *cost of pick-up and delivery;* E. *the resulting cost of freight service operation.*

A. *Cost of Present Airline Operation*

Since no air freight service from which useful statistics might be obtained operates in the United States today, a method of determining the probable costs thereof is to ascertain those of a typical long-distance passenger service, such as United Air Lines' and then allow for both the economies and the extra expenses of freight service operation. For 1936, the last year in which Boeing 247-D's were flown almost exclusively, United Air Lines' operating costs (not including retirements) were 56.3 cents per revenue mile.[25] The allocation of these operating costs to the various divisions of expense, both as percentages of the whole and as portions of the 56.3 cents' cost per mile, is shown in the following table. The costs have also been classified either as *flying expenses,* i. e., direct and variable, or as *ground expenses,* i. e., indirect and fixed.

TABLE 6

Distribution of United Air Lines' Expenditures in 1936[26]

FLYING EXPENSES

Item	*Percentage*	*Cents/Mile*
1. Pilot personnel	14.94	8.4
2. Fuel and oil	8.91	5.0
3. Overhaul and repair (materials)	5.14	2.9
4. Depreciation (incl. obsolescence)	14.15	8.0
5. Insurance	4.97	2.8
6. Passenger service	3.92	2.2
7. Passenger service personnel	4.08	2.3

25. *Annual Report of United Air Lines,* 1936; 58.2c in 1935. Operating cost per mile of Douglas DC-2 is 67.4c, of Douglas DC-3 is 71.6c, according to *Fortune,* February, 1939, p. 116.

26. Percentages supplied by Hal Nourse, Statistician of U.A.L., in letter of December 6, 1938. Items 7, 10 and 11 were supplied as one total percentage, which was allocated to these items on the basis of the proportions which corresponding items in the 1937 distribution of expenses bore to their total percentage.

GROUND EXPENSES		
8. All other operating supplies and expenses.....	8.32	4.7
9. Sales promotion and advertising.....	8.27	4.6
10. Sales promotion and advertising personnel.....	3.06	1.7
11. All other personnel (incl. employees' Christmas gift of .44%).....	21.42	12.1
12. Taxes	2.82	1.6
Total	100.00	56.3

Table 6 provides a representative itemization of the various costs of operating a long-distance passenger service, and will serve as the basis of a study of economies possible in a long-distance air freight service.

B. *Economics of Freight Service Operation*

If United Air Lines' 1936 coast-to-coast passenger service were operated today exclusively as a freight airline, the items listed in Table 6 as *ground expenses* would probably not be changed a great deal. To be sure, because of the trend toward higher taxes since 1936, an expense such as Item 12 would doubtlessly be larger. Many of the operating supplies and expenses now come higher than they did three years ago. Yet Items 9, 10 and 11 would almost certainly decrease. Sales promotion expense would be smaller, not because of less attention to the promotion of freight traffic, but because the public can much more readily be persuaded to ship goods by air than to travel by air themselves. As for "other ground personnel," freight requires less handling than do passengers. Of course, packages do not walk onto airplanes, but neither do they ask questions, demand comforts and have to be restrained from running into whirling propellers. Hence, although there would be both increases and decreases in the various items of ground expense, it is a safe conclusion that, were United Air Lines' 1936 transcontinental passenger service operated today as a freight business, the ground costs listed in Table 6 would be no greater than those shown therein.

The seven *flying expenses* listed in Table 6 are much more productive of economies. Contrary to a widespread impression that operating costs invariably increase with decreased flying speed, very substantial savings can be made. It is, perhaps, a fair criticism of American aviation that, in the keen endeavor to reduce flying time of schedules, economy has been continually sacrificed for speed. Few attempts have been made to discover what may be gained by reversing the process. The following examination of economies possible in the seven items of flying expense of Table 6 is based in

part on an average flying speed of one-third less than that of United Air Lines' Boeing 247-D's in 1936.[27]

1. *Pilot personnel.* The first item listed in Table 6 represents the compensation of the first and second pilots, who comprised in 1936 the usual avigating complement of a passenger airplane. A fair estimate of the average annual income of a first pilot is $8,500.[28] Second pilots commence at about $190 a month, which is gradually increased to $265 over a period of three years. Reserve first pilots, who act as either first or second pilots, earn from $295 to $335 a month. These amounts, although based on recent practice, are fairly indicative of 1936 pilot pay. (Actual flying is limited, either by government or company regulations, to about 1,000 hours a year.) Since the acting second pilot is just as likely to be a reserve first pilot as a second pilot, it seems reasonable to take the average of the pay of both classes, $271.25, or $3,255 a year, as the cost of the acting second pilot. Adding this to the first pilot's salary of $8,500 a year results in a total passenger piloting cost per 1,000 flying hours of $11,755, or $11.75 an hour.

We need not expect the same highly paid piloting personnel of the passenger airliner in freight service. Responsibility for the freight airplane may be entrusted to a pilot who either has attained the rank of reserve first pilot in passenger service or has the same ability, training and experience as a reserve first pilot. To assist in piloting as well as in handling cargo, a new class of *apprentice pilot* could be set up. This class would be intended for young men who have received commercial pilot and instrument ratings, but who have not had sufficient experience to entitle them to employment as passenger second pilots. With the Government undertaking to give elementary training to 75,000 men during the next five years, a wealth of trained but inexperienced young pilots may be anticipated.[29]

The national defense program will for some time tend to reduce the supply of army-trained pilots available for civil flying.[30] Hence it is definitely in the interest of the airlines to insure some degree of independence of army reserve pilots by creating their own source

27. U.A.L.'s 1936 schedules appear to have required on the transcontinental route an average ground speed of 153 m.p.h. westbound, 183 m.p.h. eastbound. Suggested average ground speed for freight service, 102 m.p.h. westbound, 121.3 m.p.h. eastbound. *Cf.* Appendix V.

28. *Fortune*, February, 1939, p. 112.

29. Although the Government proposes to give these 75,000 men only 65 hours of flight experience, and about 200 hours of solo flying are necessary to qualify for commercial pilot and instrument ratings, it is a reasonable assumption that many students will continue training at their own expense.

30. A publication of the U. S. Army, *Flying Cadets of the Army Air Corps*, 1937, says, "It is anticipated that all graduates of the Air Corps Training Center will be needed for some time to come on tours of extended active duty with tactical units of the Air Corps." Recent national legislation confirms this anticipation.

of pilot supply. They might well devise a system whereby a qualified graduate of an approved flying school, who had secured commercial pilot and instrument ratings, could be employed as an apprentice pilot in freight service, advance after a prescribed period to second pilot in passenger service, to reserve first pilot in freight service, then to reserve first pilot in passenger service and finally to first pilot in passenger service.

It is to be expected that the Air Line Pilots Association might object to reserve first pilots' being given new responsibilities, including a preponderance of night flying, without additional compensation, as well as to the creation of an apprentice pilot group. Yet a proposal which brings about a large new demand for pilots and provides two new steps of gradually increased responsibility on the way up to the position of first pilot is ultimately in the best interest of the Association and its members. Most airline pilots frankly dread the day when, according to the necessarily exacting standards of their employers, they will have reached their age-limit of usefulness in passenger service. By finding a use for some of them as freight pilots after their retirement from passenger service there would be less waste of pilot talent to the industry and an extension of the period during which the airline pilot could make a living in the field of his training.

With an average pay of about $4 an hour for the reserve first pilot in charge of an air freighter and a salary-in-training of about $2 an hour for the apprentice pilot, one hour of freight piloting would cost $6. Since the average flying speed of the freight service would be one-third less than that of United Air Lines' coast-to-coast route in 1936, a half more time would be necessary to travel the same distance, and one and a half hours of freight piloting at $9 would be the equivalent of one hour of United Air Lines' 1936 piloting cost of $11.75 an hour. Therefore, the freight service operation economy based on Item 1 of Table 6 may be expected to approximate 23.4%, or 1.96 cents per mile.

2. *Fuel and oil.* This item of expense is influenced by flying speed for the reason that less power is required at a slower speed and therefore less fuel. Since freight service imports a considerably decreased average flying speed, the fuel saving over comparable passenger service requirements may be substantial. In the interest of simplicity, the saving in oil cost will be assumed to be included in that of fuel.

As has been stated before, the average flying speed of a coast-to-coast passenger service, such as that upon which Table 6 was based, may be decreased one-third for freight purposes. Since in

1936 the Boeing 247-D's were cruised over the transcontinental route in competition with the new Douglas DC-3's close to the Boeing's maximum cruising speed at about 180 miles per hour, the normal cruising speed of the Boeing in a similar freight service may be expected to approximate 120 miles per hour. It will be seen later that freight operation may involve an increase in the present allowable gross weight of 14,000 pounds to 16,240 pounds; at the above freight cruising speed this would make possible a decrease of brake horsepower required from 850 to 500.[31] But at one-third slower average flying speed a freight airplane would have to fly a half longer in time to cover the same distance. Hence 750 of its brake horsepower-hours would be the equivalent of 850 passenger service brake horsepower-hours. This would constitute a saving of about 12 per cent in power required.

Freight service would involve more frequent stops with a greater number of landing, take-off and climb operations than in United Air Lines' 1936 passenger service. Although this would tend to increase fuel consumption, it would not add substantially to total fuel consumption.[32] Offsetting this increase is the fact that the saving in fuel consumption would be slightly greater than the above saving in power required, because the efficiency of the more recent carburetors is greater than that of the carburetors used in 1936. Greater efficiency is possible even though the freight airplane would operate at a low power factor.[33] In view of the above considerations it is a fair conclusion that, with freight operation, fuel costs would be smaller than Item 2 of Table 6 by about 12 per cent, or 0.6 cents per mile.

3. *Overhaul and repair (materials)*. Future costs of this kind are always difficult to estimate. The extreme complexity of the aircraft engine makes it impossible to predict what part will fail first, and when. Engines are not ordinarily operated to the point of failure, or under precisely the same conditions over long periods; therefore, an understanding of their exact reliability is difficult to obtain from experience. What material expense may be avoided with a large decrease in flying speed is particularly hard to make.

31. Based on information supplied by J. Kylstra and W. E. Beall, Chief Engineers, Boeing Aircraft Co. (CDi .0134; CDo & CDp .0273; Prop. Eff. .85), and on E. P. Warner, *Airplane Design. Performance*, N. Y., 1936, p. 635.

32. Assuming a specific fuel consumption of .85 for take-off for two minutes, of .70 for climb to cruising altitude for 18 minutes, and of .48 for cruising, approximately 10 gal. of fuel would be used for an extra take-off and climb, when operating a Boeing 247-D powered with P & W. S1H1G engines. This is to some extent compensated by decreased consumption during the glide for landing. 10 extra stops on a transcontinental flight would increase total fuel consumption about one per cent.

33. Correspondence in November, 1938, with Bendix Aviation Corp. indicates that under freight operating conditions assumed herein the new Stromberg metering injection carburetor would enable specific fuel consumption of .48 lbs. per brake horsepower-hour or less, and would not adversely affect maximum power for take-off.

One thing, however, is certain: this saving would be substantial.

Aviation engines are used most severely. Necessarily light for the power produced, they are, figuratively speaking, pounded on the back to develop sufficient power for take-off, then cruised at or close to the maximum power for which they were designed to be cruised.[34] Based upon such hard usage, the normal period between major engine overhauls, when most replacement costs occur, varies from 300 to 700 hours; for United Air Lines' Pratt & Whitney S1H1G engines in 1936, the overhaul period was 450 hours.[35]

What little comparative data exists confirms the expectation of substantially reduced maintenance material cost with a decreased cruising power factor. This is demonstrated in the following examples of overhaul practice. 1) By more moderate usage of their Pratt & Whitney S1H1G engines, after the addition of Douglas DC-3's to their fleet, United Air Lines was able to extend the prior major overhaul period of 450 hours to 600 hours. Recently the Civil Aeronautics Authority authorized Pennsylvania Central Airlines to increase to 700 hours the overhaul period of their Boeing 247-D's powered with this type of engine.[36] 2) With much of Pan American Airways' trans-Pacific flying at 40 to 50 per cent of maximum power, overhaul costs are remarkably low.[37] 3) U. S. Army Air Corps' maintenance regulations require a major overhaul every 75 to 300 hours for its severely used engines, the comparable civil models of which need such attention only every 300 to 600 hours. These cases illustrate a relatively minor change in power usage. The power usage decrease contemplated for freight operation would be much greater. Drastically diminished temperatures, pressures, inertia and friction forces and other changed conditions of slow freight operation would effect a much more impressive decrease in wear and tear than the above cases illustrate.

A helpful study of the increase in engine reliability to be expected with decrease of power usage indicates that, in a case involving as large a drop in cruising power factor as that proposed herein, engine reliability should be approximately tripled.[38] Hence,

34. The generally advertised cruising practice of using 55 to 70% of power available is misleading, in that a larger safety factor may be construed than exists: aircraft engines are designed to be used over indefinite periods at no more than 55 to 70% of maximum power, and hence are actually cruised at about 100% of the power output indicated as safe for that particular operation by the manufacturer.

35. A. F. Bonnalie, *Air Transportation*, Boeing School of Aeronautics, 1938, p. 132.

36. According to L. Harris, Supt. of Maintenance, P.C.A., extension "was given after C.A.A. inspectors had carefully analyzed two engines which had been operating 900 hours with only routine inspection and checks." *American Aviation*, July 1, 1939.

37. Conversation with Div. Inspector of Pan American Airways' Pacific Operations, February, 1939.

38. E. T. Allen and W. B. Oswald, *Aviation*, March, 1935, p. 89. Also E. P. Warner, *op. cit.*, p. 453.

with a one-third slower cruising speed, a maintenance saving per mile of more than one-half is indicated for freight operation. This saving would be lessened somewhat, first, by increased wear and tear of extra power requirements necessitated by more frequent stops and, second, by the fact that the percentage of airplane structure maintenance economy would not be quite so great as that of the engine. Concerning these two reservations, it might be pointed out: first, that the wear and tear of extra power requirements, like the extra fuel requirements of a take-off operation discussed in the previous section, would doubtlessly constitute a very insignificant portion of all wear and tear; and, second, that airplane structure materials cost (excluding passenger equipment) was a small fraction of United Air Lines' 1936 overhaul and repair expense. A consideration of all the foregoing factors supports the conclusion that a conversion of fast passenger service such as that referred to in Table 6 to slow freight operation would result eventually in an overhaul and repair materials economy of approximately one-half, or 1.45 cents a mile.

4. *Depreciation (incl. obsolescence)*. Depreciation constitutes an appreciable portion of the cost of operating a passenger service. A large percentage of United Air Lines' total depreciation charges in 1936 was for airplanes and engines, which were written off at the rate of a four-year life with $5,000 salvage value for each Boeing 247-D airplane, and 3,000 hours of service with $500 salvage value for each Pratt & Whitney S1H1G engine.[39]

In passenger service an airplane (considered without its engines) becomes obsolete long before it wears out. This would not be true with freight service. Thus United Air Lines, after acquiring a fleet of about 55 Boeing 247 airplanes late in 1933, began to replace them in 1936 with Douglas DC-3's. Although most of these Boeings have been written off,[40] almost all of them are still in useful service today, either on United Air Lines' minor routes or on routes of various smaller airlines to which they were sold or leased. There is no reason why the life of a Boeing 247-D in freight operation should not be at least twice its 1936 depreciation period of four years.

If the Pratt & Whitney S1H1G engines can be shown to have in freight usage a total life of three times that presumed in 1936, or slightly more than 9,000 hours, a saving of 50 per cent in the engine depreciation portion of Item 4, Table 6, may be made.[41]

39. Petition of U.A.L., *supra*, and U.A.L. *Annual Report to Stockholders*, 1937.

40. Petition of U.A.L., *supra*, shows all but $121,749.85 of the cost of over two and a half million plus one and a half million for conversion into 247-D's written off, as of June 30, 1938.

41. This is the 1936 depreciation rate of 3,000 hours increased one-half

Subsequent to 1936, because of a reduction of cruising speed and consequent decrease of power factor, United Air Lines was able to increase the depreciation rate of these engines to 5,000 hours with no salvage value.[42] As shown in the discussion of fuel and oil costs, with one-third less flying speed approximately one-half of the 1936 power would be required. It is reasonable to assume that the 1936 3,000 hour life of these engines would be increased to at least 9,000 hours with but one-half as much power being produced by them.

The above economies in airplane and engine depreciation would substantially diminish total depreciation charges. It seems safe to conclude that with freight rather than 1936 passenger service on United Air Lines' coast-to-coast route, Item 4 of Table 6 would be no greater than half the amount shown therein, and the saving in depreciation expense would consequently approximate 4.0 cents a mile.

5. *Insurance.* These costs present another promising opportunity for economies in freight operation. The law permits a common carrier of goods in effect to limit its liability, but prevents a common carrier of passengers from doing likewise.[43] A shipper of goods by air express can recover no more than $50 for loss or damage to his property en route, unless a special excess charge has been paid, whereas every passenger is automatically a potential lawsuit involving many thousands of dollars. Passenger insurance costs, whether carried by the airline itself or placed with an insurance company, constitute well over half the total insurance costs.[44] In freight service operation, however, passenger insurance would be entirely eliminated, and the cost of the usual $50 per shipment limited liability cargo insurance would be relatively insignificant. Provision for the latter insurance will be made subsequently in the discussion of pick-up and delivery costs. Therefore, by eliminating all passenger insurance expense, freight service operation makes possible a saving of at least half the total insurance costs.

Of the remaining items of insurance expense, some would be no greater than in 1936 and some would be less. Thus public liability, property damage, ground equipment and employees' fidelity and life insurance costs would be no more. Full hull and crash coverage, next to passenger liability the largest class of insurance cost, is determined by the value of the airplanes. Since a freight

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because of one-third slower flying speed and doubled for a 50% maintenance economy.

42. Petition of U.A.L. *supra.*

43. G. W. Ball, "Compulsory Aviation Insurance," 4 JOURNAL OF AIR LAW 52.

44. Applying the standard passenger liability insurance rate of $.00275 per passenger-mile to U.A.L.'s 1936 average seat occupancy of 6.48 and multiplying by the 1936 revenue-miles flown, 16,616,206, indicates that passenger insurance costs in 1936 were about 61% of total insurance costs.

service can use second-hand airplanes of half the value of passenger aircraft, this item need be but one-half as much. To allow one-half, or 1.4 cents a mile, as the probable economy in Item 5 of Table 6, upon conversion from passenger to freight service, is to err in the interest of conservative estimate.

6 and 7. *Passenger service and passenger service personnel.* Ever-growing competition with train and bus has resulted in an extraordinary effort on the part of the airlines to give the utmost in comfort and convenience to their passengers. Accommodations range from dictaphones to diapers and include such items as meals, blankets, pillows, magazines, games, binoculars, slippers, stationery, electric razors and drugs. Each person must have a comfortable chair and ample leg space, there must be plenty of fresh air, artificial and natural light, oxygen for altitudes above 10,000 feet, a cabin temperature between 65° and 75° and protection from noises and vibration. In constant attendance, averaging in 1936 one for each half dozen passengers, is an accomplished hostess qualified as a registered nurse. Inasmuch as the air traveler frequently is a fastidious individual, interior appointments sometimes suggest the luxuriousness of pullman cars or ocean liners. All these expenses are unnecessary in a freight service and Items 6 and 7 of Table 6 may be eliminated entirely as items of cost herein.

The foregoing economies are summarized in the following table:

TABLE 7

ECONOMIES OF FREIGHT SERVICE OPERATION

Item	*Cents/Mile*
1. Pilot personnel	1.96
2. Fuel and oil	0.60
3. Overhaul and repair (materials)	1.45
4. Depreciation (incl. obsolescence)	4.00
5. Insurance	1.40
6. Passenger service and passenger service personnel	4.50
Total	13.91

These economies reduce the 56.3 cents per mile cost of Table 6 to 42.39 cents, which may be regarded as representative of the total operating cost per mile, exclusive of pick-up and delivery and interest on capital investment, of a typical long-distance air freight service in the United States.

Before leaving the subject of air freight economies, it should be said that the greatest savings possible lie in a direction relatively unexplored. This is the construction of airplanes designed

solely for freight use. To be sure, aircraft such as the tri-motored Ford, the Fairchild XC-31 and the Bellanca Aircruiser have been produced with half an eye to use as freighters. More recently other manufacturers, including Boeing, Douglas, Lockheed and Curtiss-Wright, have built larger faster airplanes for use either as passenger or all-cargo craft. But the former class of airplane lacks large capacity; the latter, slow-speed economy. Unless an airplane has the qualities both of large capacity and slow speed, low cost freighting is difficult. The most promising undertaking was announced by the Howard Aircraft Company early this spring: a twin-engine freighter of 1,500-2,200 total horsepower, 20,400 pounds gross weight, 8,000 pounds payload, 149 miles per hour cruising speed and wing loading of about 20 to 1. However, this interesting freight-plane has not, at this writing, been produced.

The chief requisite of freight aircraft is low operating cost. To some extent greater economy of operation can be accomplished, as is being done currently with passenger airplanes, by increasing size. Air transportation is no exception to the rule that operating costs per unit of service tend to decrease with increased size of transportation vehicle used. Larger economies, however, should result from the air freighter's low speed requirements. For high speeds, wing and surface areas must be reduced, because the chief reaction (parasite drag) of the air particles to the airplane's shape and surface varies directly as the *cube* of the airplane's speed. Considerable additional power is needed to pull the airplane through the air at an only slightly increased speed. The slow-flying freighter may be designed with large wing span and wing area, similar to a sailplane, which is the most efficient type of aircraft because it has practically no parasite drag loss and can utilize large wing span and area virtually to float through the air. With competition compelling steadily increasing speeds, the modern passenger aircraft designer is forced to utilize ever-mounting wing and power loadings, and, in point of proportion, the ultimate Wright powered table-top is not so far off. The percentage of total weight required for engine and fuel fails to diminish with increased size. Although even freight operating requirements call for a compromise between absolute aerodynamic efficiency and speed, a specially designed freighter should, in respect to both reduced power requirement and increased payload capacity, have a great advantage over its high-speed passenger counterpart. Accordingly, one may expect the operating costs of a specially designed air freighter to be definitely less than those of a passenger airliner of similar size and initial cost.

Other features required of the specially designed freighter in-

clude a fuselage with unobstructed hold, removable compartment spacers and containers, large conveniently located hatches, ring-bolts to prevent cargo from shifting, wing flaps and an efficient temperature control system. It does not seem too much to hope that before long economical Diesel engines may power large, slow air freighters, particularly on long-distance, non-stop flights.[45] Then, perhaps, flying freight cars will be as common aloft as are Diesel trucks and trailers on the highway today.

C. *Increases in Payload of Freight Service Operation*

These increases are of three kinds: conversion of certain dead weight to payload, increased allowable gross weight and improved load factor.

The modern airplane carries a most impressive quantity of fuel for its engines' consumption. In 1936 the Boeing 247-D regularly lost close to a ton of potential payload to this requirement.[46] We have seen that, because of the decreased speed required of a freight service, a given distance can be flown using approximately 12 per cent less fuel than the same airplane normally consumed in passenger service in 1936. It will be shown subsequently that a freight airliner will make at least twice as many stops as is customary in passenger operation.[47] Because of these two circumstances, the 1936 fuel load could be cut 12 per cent for the decreased rate of fuel consumption and then halved for twice as many opportunities to refuel, resulting in an average required fuel load of only 787 pounds. This supply of fuel would be sufficient under normal conditions for the 154 mile average hop shown in Appendix V and return, with three-quarters of an hour reserve supply remaining, and would, considering the shorter average hop of the freight airline, seem to provide the same degree of protection as that required by modern passenger airline fuel regulations. Freight airplanes, like the present airliners, can ordinarily take advantage of a less than 100 per cent load factor, or even reduce payload, to add to the above fuel supply when weather conditions make this advisable.[48] The increase in payload would, therefore, approximate 1,001 pounds. To this may be added a saving of 430 pounds for elimination of a stewardess and passenger fittings.[49]

45. Diesel aircraft engines are in common use in Germany today, and have weight-power ratios which compare favorably with our gasoline engines.
46. Maximum fuel load 1,788 lbs.
47. Thus the schedule given later for a coast-to-coast service shows 20 intermediate stops with an average distance between them of 154 miles, as compared with U.A.L.'s 1936 schedules for the same route showing an average of 8 intermediate stops with an average distance between them of 330 miles.
48. *Operations Program and Policies,* United Air Lines, January, 1938.
49. McMillen, *op. cit.* (1935), p. 376, cited U.A.L.'s figure of 600 pounds for stewardess, passenger fittings and one pilot.

The gross weight for which an airplane may be certificated is limited by the weight which it can accommodate when landing at sea level with power off at the maximum speed provided for its class by Section 04.700 of the Civil Air Regulations. Payload is based upon this gross load, since it consists of the gross load minus the weight of the airplane, crew and fuel. The above Section provides that an airplane of 20,000 pounds or less may have a landing speed of 65 miles per hour at sea level if certificated for passenger transportation, but of 70 miles per hour if certificated for the carriage of goods only. Therefore, passenger airplanes, when used for freight service, may be certificated for a greater gross weight, one which is proportional to the square of the increased landing speed.[50] In the case of the Boeing 247-D, with a present certificated gross weight of 14,000 pounds, this would amount to an increase of approximately 16 per cent, or 2,240 pounds, all of which would constitute increased payload.

The question may be raised whether the increased gross weight permits a sufficiently large take-off safety factor. Airline pilots commonly use all the power available on take-off so that, should the engines fail, the forward speed would provide sufficient lift to enable maneuvering for a safe landing. At high-altitude airports, where less dense air makes necessary more forward speed for the same lift, pilots find none too much reserve power under present operating conditions. An increase in gross weight of 2,240 pounds would reduce the take-off and landing safety factor. If experience should demonstrate that the Government's freight landing speed regulation provides too small a reserve power margin, several solutions are possible: 1) take-off strips may be lengthened, or 2) a smaller single-engine airplane, such as the Bellanca Aircruiser or the Stinson SR10,[51] may be used in conjunction with regular sections to transport a part of the loads between high-altitude airports. Schedules might be devised so that one airplane could be used to supplement regular sections in alternate directions by a shuttle service arrangement.

The third increase of payload with freight operation would be due to a higher load factor for the following reasons: 1) A freight airline would not need the latest and largest type of airplane, as do passenger carriers, but could estimate the actual traffic and use the type and size of airplane commensurate with such demand. 2) A greater frequency of stops would increase the freight airline's opportunity to pick up business. 3) A freight service would not

50. E. P. Warner, *op. cit.*, p. 595.
51. Total flying cost of Stinson SR10 with over 1,000 lbs. freight payload capacity is approximately seven cents per mile, according to figures contained in letter of November, 1938, from Stinson Aircraft Co.

require as many schedules for the same amount of business as does passenger and mail service. 4) A deferred delivery arrangement, to be discussed subsequently, which provides for rate reduction in return for carriers' option to hold shipments over for a day or two, is an attractive possibility in long-distance freight operation. 5) Shipment of goods, as demonstrated by the following Table 8, is subject to smaller seasonal variation than are passenger loads. Table 8 is an analysis of the Civil Aeronautics Authority's monthly figures for revenue passengers and pounds of express carried on the airlines of the United States during the past four years, and shows the ratio of the lowest to highest monthly load in each year for both passenger and express traffic. Higher ratios, signifying less seasonal variation, are to be noted for express.

TABLE 8

SEASONAL VARIATION OF LOADS ON U. S. AIRLINES
(Percentage of lowest to highest monthly load)

	1935	1936	1937	1938	4 *Yr. Average*
Passengers	38	44	43	52	44.2
Express Pounds	47	48	71	48	53.5

During 1936 seat occupancy of United Air Lines' Boeing 247-D's averaged 64.8 per cent.[52] (Their percentages of seat occupancy in 1937 and 1938 were smaller than in 1936, which was mainly attributable to use of the larger Douglas DC-3's.) In view of the reasons cited in the above paragraph, it may conservatively be estimated that the load factor of a long-distance freight service of the kind described herein, after normal operation had been established, would be about 75 per cent. With a present payload of 2,410 pounds, conversion from dead to payload of 1,001 pounds for fuel and 430 pounds for stewardess, fittings, etc., and 2,240 pounds' increase in maximum gross weight, the total payload capacity of the Boeing 247-D would be 6,081 pounds, of which 75 per cent, or 4,560 pounds, should be the average payload.

D. *Cost of Pick-up and Delivery*

One of the greatest obstacles to the development of either air express or air freight has been the necessity of providing inexpensive yet adequate pick-up and delivery. Conceivably freight service might be merely from airport to airport with distribution and collection left to the shipper or any enterprising local agency. This ar-

52. U.A.L. *Annual Report to Stockholders*, 1936.

rangement, however, would not be acceptable to a public already accustomed to a high degree of service.

A possibility exists of collaborating with the United States Post Office Department, in order that the extensive collection and distribution facilities of that branch of the Government might be used in conjunction with an air freight service. This idea has some merit in that a new and useful service could be effected with very little cost to the public. Yet, regardless of how the Government might feel about such an expansion of the Post Office's traditional functions, it is certain that those who develop the air freight industry would prefer to remain entirely independent of federal financial assistance. Experience with air mail subsidy has shown the value of such independence.

Nearly all the airlines transporting express today in the United States collaborate with the Air Express Division of the Railway Express Agency (hereinafter referred to as R.E.A.) under separate but identical contracts, whereby R.E.A. handles pick-up and delivery in return for all out-of-pocket expenses plus one-eighth of the balance of gross air express revenues.[53] This arrangement has many advantages. The public is given an efficient, complete and coordinated express service on a single waybill to or from any point in the United States that can be reached by airline or railroad. Both the airlines and R.E.A., by an insignificant burden on existing facilities, add to their revenues.

Satisfactory as these agreements may appear to be in the present express business of the airlines and R.E.A., they are not desirable as a basis for the coordination of air freight and R.E.A. services. First, the contracts are vague, in that the portion of gross air express revenues payable to each party is dependent upon what and how great R.E.A.'s out-of-pocket expenses may be. Sound business practice disapproves of undertaking a definite service for an undetermined return. Second, the agreements require the airlines to take a greater risk, that is, of losing an airplane, and to perform a greater service, with respect to distance covered, yet entitle them to a profit only after the out-of-pocket expenses, which may be construed to cover essentially all expenses, of the R.E.A. have been provided for. This means that R.E.A., after expenses plus one-eighth of the balance, could profit on shipments for which the airlines do not receive their expenses out of the remaining seven-eighths of gross air express revenues. Third, the air carriers would have a more vital interest in the air freight business than R.E.A. and should not act as quasi-agents of the R.E.A. It would be better

53. Annual Report of R.E.A. to Railroad Comm. of Calif., 1938.

for R.E.A. to act as agent of the airlines, as it does for the railroads; or at least the airlines should be independent contractors, as is Pan American Airways in its relationship with R.E.A. Finally, R.E.A., a corporation entirely owned by the airlines' chief competitors, is in a position to be suspected of stifling development of the air transportation industry. This suspicion has been voiced in some quarters and the claim made that from the promotional angle air express is not getting its fair share of attention.[54] Such an attitude, however unfounded and regrettable, is to be expected with the present arrangement and constitutes an undesirable reflection upon the integrity of R.E.A.

Supposing the air freight carriers were to employ R.E.A. as their agent to collect and deliver parcels for a flat charge per pick-up and delivery, what should that charge be? At present R.E.A., under the above described contracts, gets slightly more than one dollar for each pick-up and delivery,[55] which is approximately 36.4 per cent of the average amount of tariff paid by the shipper. Without raising the question whether an arrangement which results in the division of total gross air express revenues on the basis of one-third to R.E.A. and two-thirds to the express air carrier is fair, in view of the relative values of service of and burdens on each, the opinion is ventured that the flat pick-up and delivery charge of R.E.A. ought not to be so high as one dollar for an air freight service. In most large cities, local trucking or express service is available for much less than a dollar. R.E.A. itself provides local express service for wholesalers and retailers, which ordinarily involves an intermediate delivery and pick-up to its own clearing warehouse, at a rate which varies according to the city but which usually approximates 25 cents for 40 pounds and a slightly lower rate for heavier shipments. Special handling to insure prompt delivery costs an additional 50 cents, making a total charge, in the case of special delivery from and to such remote places as the usual airport, of 75 cents per pick-up and delivery (assuming the average weight of air freight shipment to be less than 40 pounds). One other element of cost must be provided for in the flat charge. The present arrangement between R.E.A. and the air express carriers requires the former to be responsible for claims for losses under the $50 free insurance coverage given for each air express shipment. Moreover, in the previous discussion of insurance costs, it was stated

54. Editorial, *American Aviation*, November 1, 1938.

55. Assuming total air express revenue in 1937 was product of 624,048 (total shipments) and $2.88 (tariff for average shipment of 6.87 lbs. and 850 miles). Of this, $1,152,971 was paid to airlines (Annual Report of R.E.A. to Railroad Comm. of Calif., 1937). Balance, amounting to $1.05 per shipment, or 36.4% of tariff, must have been the share of R.E.A.

that cargo insurance would be dealt with as an element of pick-up and delivery expense. Since R.E.A.'s regular insurance charge to the public for either rail or air express shipments is 10 cents per $100 valuation, an additional allowance of 5 cents for the $50 free insurance would seem to be adequate. Therefore, the total flat charge for an air freight pick-up and delivery up to 40 pounds should be no more than 80 cents. This is slightly less per shipment than R.E.A. receives at present in the air express business, but, with a large increase in this type of business reducing unit cost of handling, it is probably high enough to permit R.E.A. a profit. Together with the other economies indicated herein, it would make possible the air freight rates necessary for a considerably increased business both for the air carriers and R.E.A.

The alternative to the above arrangement is for the air freight carriers to set up their own delivery system throughout the United States. Even a pioneer air freight service such as that referred to herein may expect, using local trucking, parcel delivery and telegraph messenger services to provide adequate collections and distributions at an average cost of about one dollar. Later, an express agency, similar to R.E.A. but independent of the railroads, could be set up for the benefit of all the air carriers including, too, air express services. The recently instituted Civil Aeronautics Authority, which has already evinced an interest in this matter, could be most useful in compelling the necessary unity of action among all the airlines.

However, the public interest clearly requires the avoidance of duplicating existing delivery facilities if possible. It would also seem to be in both R.E.A.'s and the airlines' interest to encourage the same cooperative relations in regard to the future freight business as those which exist in the air express enterprise today. Therefore, it seems likely that terms something like those suggested above would be agreeable to all concerned.

E. *Resulting Cost of Freight Service Operation*

The foregoing analysis of the costs and possible economies of a freight service based on United Air Lines' coast-to-coast route and 1936 passenger service may serve as an indication of the total operating cost of any long-distance air freight service. Starting with the known cost of operating a passenger-mail-express service and making deductions for various economies possible with freight operation, it was found that the total cost per mile, exclusive of pick-up and delivery, amounted to 42.39 cents.[56] Taking again as the

56. *Cf.* p. 475.

average payload 4,560 pounds, the 42.39 cents a mile cost amounts to .0093 cents a pound-mile. Pick-up and delivery expense has been estimated at 80 cents per shipment. With present express shipments averaging 6.87 pounds and 850 miles and an air freight tariff decidedly favoring heavier and longer hauls, a reasonable estimate of the probable weight and distance of the average air freight shipment is 15 pounds and 1,250 miles, or 18,750 pound-miles. This would result in pick-up and delivery costs of .0043 cents per pound-mile. Therefore, the total operating cost, exclusive of interest on capital investment, of a long-distance air freight service, using Boeing 247-D aircraft under the conditions outlined in the foregoing study, may be expected to average approximately .0136 a pound-mile, or 27.2 cents a ton-mile.[57]

III. Rates and Profits

The probable large demand for an air freight service and the possibility of its operation at low cost having been determined, air freight rates must be found which will not only cover all expenses but provide reasonable profit as well. Rates will be considered applicable to all air freight, regardless of the distinction made in the study of costs between operations of an existing major airline and those of a new airline. The subject of profits, however, will be discussed briefly with these alternatives in mind.

Rates

A suitable rate structure will be analyzed under the following five sub-headings: A. *basic rates;* B. *space;* C. *value;* D. *special classes;* E. *deferred delivery.* Because of lack of precedent in establishing air freight rates, any tariff would be necessarily experimental, and the most useful rate structure is one capable of future readjustment in whole or in part. A general tariff level is necessary, which, although low enough to induce adequate traffic, will produce sufficient income to cover all expenses plus a reasonable profit. And, not of least importance, the basic tariff structure should be quite simple, in order that it may be understood clearly and applied easily by freight-line employees as well as the entire shipping public.

57. The larger payload and economies possible with airplanes such as the Douglas DC-3 would result in a considerably lower cost per pound-mile. Applying the same percentages of economies in flying expenses shown in Table 6 to the 1938 operating expenses of U.A.L., more than three quarters of whose flying is performed with Douglas-3's, results in an operating expense of 53.44 cents per mile. Maximum payload is 6,615 pounds, increased allowable gross weight 3,720 pounds and elimination of non-essential furnishings, etc., 716 pounds. Computing as above with load factor 75 per cent indicates a freight service cost, exclusive of interest on capital investment, of .0107 cents per pound-mile, or 21.4 cents per ton-mile.

A. *Basic Rates*

In existing rail and air transportation tariffs one might expect to find a suitable framework for air freight rates. However, anybody who has had occasion to make shipments by rail, either of freight or express, would probably advise against encouraging the new air freight industry to follow in the rate-making footsteps of the railroads. The amazing, expensive mass of rates, provisions, regulations and decisions, which fill thousands of volumes, create endless bitter controversy and can be applied only by relatively few experts, has to no little extent helped make this proud giant one of the nation's sickest industries. Necessary or useful as this complicated set-up may be to the railroads today, air freight transportation would be wise to reject all the blocks, sub-blocks, scales and other ramifications of the railroad tariff structure.

The present domestic air express tariff, shown in part hereinafter in Appendix I, provides a more promising rate pattern. Its rate structure is much more quickly and easily comprehended than that of rail express. The rates of this tariff increase with distance and weight, until certain limits are reached where either no further charge is made for greater mileage or a flat charge, depending upon the distance classification, is made per pound. Of importance to both shippers and carriers as well as to the student, as probably the best indication of the relative rate burden of every class of shipper, is an analysis of this tariff in terms of rates per pound-mile of shipment. This is made in Appendix II, which shows that the air express pound-mile rate decreases with weight and distance at a gradually diminishing rate until certain distance-weight classifications (represented by the heavy type) are attained, where a flat rate of .04 cents per pound-mile is charged. At 2,450 miles the rate resumes its decrease again, this time with distance only.

In adapting the present air express tariff to the requirements of air freight, four changes seem desirable: 1) simplification. 2) greater advantage to long-distance shipments, 3) a more widespread decrease of the pound-mile rate with increased weight, and 4) a lower average pound-mile rate. These objectives are accomplished by the basic rates suggested in the following Table 9. An air freight tariff and pound-mile analysis thereof utilizing this rate basis are shown subsequently as Appendices III and IV respectively.

TABLE 9

SUGGESTED AIR FREIGHT BASIC RATES

	Distance Zones		
Weight	To 1000 *miles*	1001-2000 *miles*	2001-3000 *miles*
Up to 10 lbs.	$1.50	$2.50	$3.50
Each lb. over 10 lbs.	.15	.25	.35

This rate basis offers an innovation in transportation tariff structures. A flat rate per pound, with all weights below 10 pounds considered as 10 pounds, is offered in each of three distance zones. This principle has long underlain the United States postal rate structure, helping make possible the remarkable economy and efficiency of that service, which most people now take for granted. The idea has also been adopted for some telegraph charges and is being vigorously advocated for railroad passenger and freight tariffs.

The cardinal virtue of the postalized-rates principle is the ease with which the tariff can be applied, understood and advertised. Simplicity and the spreading of the costs of service among a large class of patrons are the substance of the idea. Economy is achieved by avoidance of all the varied expenses which grow out of the establishment and application of rates. Strong psychological appeal can be made by emphasizing the maximum distance obtainable with each flat rate, in advertising slogans such as, "Air Freight to *Any* State—ten pounds from $1.50 to $3.50." The flat-rate principle, which after all differs from other tariffs only in the degree of importance attached to the elements of distance and weight, may be used throughout the tariff, as in Table 9, or may be restricted to the lower weight classifications. Thus four or more zones might be substituted in place of the three suggested. Or the flat-rate feature might be abandoned after 10 pounds, up to which point the principle has its maximum usefulness.

The four changes suggested by the study of the air express tariff structure are fulfilled in the following ways. 1) The tariff is completely simple and understandable, as shown by a comparison of Appendices I and III. 2) A greater advantage lies with more distant shipments, which results automatically from application of the flat-rate principle in each of the distance zones, as is demonstrated by the pound-mile analysis of Appendix IV. The lowest pound-mile rates appear where they are most wanted, viz., for coast-to-coast shipments of 10 pounds or over, and thus tend to improve load factor by encouraging long, heavy hauls. 3) A more widespread decrease of the pound-mile rate with increased weight (up to 10 pounds) in the suggested air freight tariff may be seen by comparing the pound-mile analysis of the air express rates, shown in Appendix II, with that of the air freight tariff, shown in Appendix IV. The former analysis reveals that the air express pound-mile rate for more than half of the classifications (represented by heavy type) is the same for all weights in any given distance classification. This has the effect of offering no inducement to shippers to integrate shipments. Thus a consignor may send separately to a

transcontinental destination 12 two-pound packages for the same price he would pay if he were to unite them into one 24-pound parcel, before shipment. But the difference in expense to the airlines and to R.E.A. is very great: when the packages are sent separately, they involve 12 times as much handling and insurance responsibility. Appendix IV shows that the suggested air freight tariff offers decreasing pound-mile rates up to 10 pounds in all distance classifications. Beyond 10 pounds there is less incentive for offering decreasing pound-mile rates. 4) A comparison of the same two appendices shows that the fourth objective has been attained, viz., a low average pound-mile rate. The average rate of 30 cents a ton-mile, or .015 cents a pound-mile, indicated in an early part of this study as necessary to attract the large latent demand for air freight, appears to be offered *approximately* in the suggested tariff. If, however, the average rate should prove too high (an effort has been made to suggest rates slightly higher than are needed for an .015 cents per pound-mile average), subsequent readjustment downward may be accomplished easily by altering the particular amounts proposed. Protection against possible loss on the average pound-mile rate is made evident by Appendix IV, which shows that only on shipments of over 2,850 miles and 10 pounds is there a pound-mile rate of so little as .012 cents. This amount is only a trifle less than the rate shown in the study of costs to constitute the break-even point and it is easily counter-balanced by the preponderance of pound-mile rates greater than the break-even rate in the balance of the tariff.

A comparison of the suggested air freight rates with the present air express tariff indicates that the airlines' profitable express business is challenged severely only in the heavier long-distance classes, from which as has been shown air express derives little business today. The following Table 10 illustrates the relation of rail express and air express rates to those suggested for air freight between various important cities.

TABLE 10

ILLUSTRATIVE AIR EXPRESS, RAIL EXPRESS AND SUGGESTED AIR FREIGHT RATES

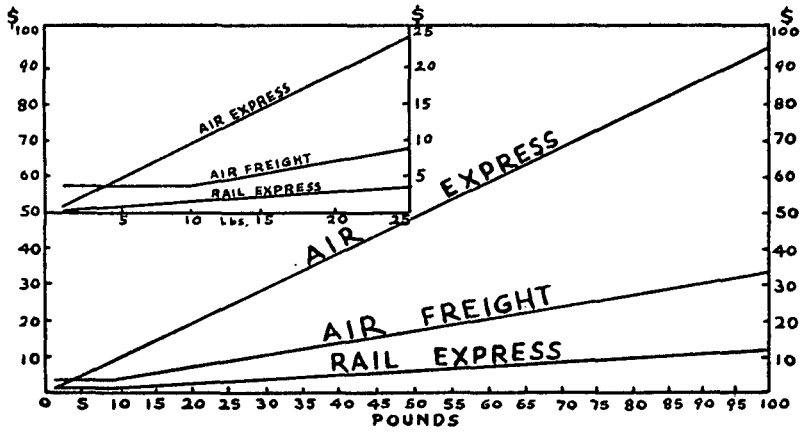
10 lbs.	*New York to:* *Chicago*	*Kansas City*	*Los Angeles*	*Chicago to:* *San Francisco*
Rail Express	$0.65	$0.70	$1.40	$1.15
Air Express	3.12	4.92	9.60	8.00
Air Freight	1.50	2.50	3.50	2.50

	New York to: *Chicago*	*Kansas City*	*Los Angeles*	*Chicago to:* *San Francisco*
25 lbs.				
Rail Express	1.15	1.52	3.33	2.72
Air Express	7.00	12.00	24.00	20.00
Air Freight	3.75	6.25	8.75	6.25
100 lbs.				
Rail Express	4.18	5.67	12.92	10.45
Air Express	28.00	48.00	96.00	80.00
Air Freight	15.00	25.00	35.00	25.00

Competition of air freight with air and rail express is most likely in the long-distance heavy-weight classifications. Figure 1 illustrates graphically the relationship of the transcontinental rates of these services up to 100 pounds.

FIGURE 1

AIR EXPRESS, RAIL EXPRESS AND SUGGESTED AIR FREIGHT TRANSCONTINENTAL RATES
(Curves Approximate)



The above Table 10 and Figure 1 demonstrate in a small way that, without the ramifications of the railroad express tariff and without all the detail of the air express tariff, an effective air freight rate structure is possible. This may be achieved by application of the flat-rate principle. It is to be hoped that those who develop air freight transportation will see fit to use this principle, either in whole or in part.

B. *Space*

Another problem in setting up a suitable air freight tariff has to do with an airplane's limited amount of space. The airplane as a vehicle of transportation is a relatively small unit, with high initial and operating costs. When the demand for space exceeds that which is available, we cannot simply hitch on another box car or trailer; a new unit, complete with power plant, crew and all the equipment of the first, must be provided. In order to operate economically, the freight airplane's load factor must be made as high as possible. High revenue yielding shipments of proper density must not be sacrificed for bulky, low revenue yielding packages. This is why the Domestic Air Express Tariff provides that a shipper shall be allowed 400 cubic inches of space per pound of shipment and shall be charged one pound for each 400 cubic inches in excess thereof. Similarly the Pan American International Air Express Tariff has a space limitation of 200 cubic inches per pound.

Streamlining and other aerodynamic considerations cause space rather than weight to be at a premium in the present-day airplane. Since, as we have seen, freight operation enables an increased payload, the space-weight ratio for a converted passenger airplane is likely to be especially low. Thus the Boeing 247-D, with a total payload capacity of freight use of 6,081 pounds[58] and an available cabin space of about 462.9 cubic feet,[59] would, allowing sufficient passage-way, have a space weight ratio of 131.8 cubic inches per pound. The Douglas DC-3 with available cabin space, less passage-way, of about 1,320 cubic feet would have a space-weight ratio of 206.4 cubic inches per pound. Although the future may bring aircraft of radically different design, it seems hardly likely that a ratio much greater than that of the Douglas can be counted upon for many years to come.

Fortunately the vast majority of commodities that might be transported by air freight have space-weight ratios less than that of the airplanes just considered. The following list illustrates the space-weight ratios for a few common materials in cubic inches per pound:

Steel 3.5	Water 27.4
Glass 9.6-11.5	Paper 39.3-24.0
Sugar 17.3	Cork 110.8

Only an exhaustive investigation would show what space might be occupied by various commodities when properly packed for shipping.

58. *Cf.* p. 479.

59. By actual measurement. Unnecessary fuel space would increase this a little. Use of space in after portion of fuselage presupposes alterations to provide for shifts in center of gravity and to prevent interference with tail controls.

The following Table 11 shows the space required by three of the bulkiest types of commodities which are at present shipped either by rail or air express, but which might be expected to move by air freight.

TABLE 11

SPACE-WEIGHT RATIOS OF COMMODITIES PACKED FOR SHIPPING

Commodity	*Package Dimension*	*Weight*	*Ratio*
Fruits and Vegetables	*(in.)*	*(lbs.)*	*(cu. in./lb.)*
Asparagus	19½x10½x10	34	60
Grapes	17½x16x5	28	50
Ripe figs	20x14x7	40	49
Unshelled peas	23x12x9	30	79.6
Clothing			
Dresses	28x16x4	12	149
Dresses	34x16x3	9.5	161
Cloaks	33x19x8	33	152
Coats	28x16x6.5	16	182
Cut flowers			
Roses	36x16x9	25	207
Gardenias	32x18x4	6	384

From the above table it appears that a tariff provision allowing 200 cubic inches per pound and charging one pound for each 200 cubic inches in excess thereof would be a just and practicable limitation. Only unusually bulky items such as some of the more expensive cut flowers, which now move in quantity by air express, and some loosely packed merchandise would be adversely affected. Since the space-weight ratio of all shipments on any single trip would probably average well below 200 cubic inches per pound, the small space of aircraft such as the Boeing 247-D may be expected to be adequate for this proposed space-weight limitation under normal conditions.[60]

C. *Excess Value*

Value as a factor in determining a rate schedule merits consideration. For a given size, weight and distance of shipment, the transportation of an article of much value in a sense constitutes a greater service than the transportation of one of less value. An additional fee might be charged for this greater service. Thus Pan American Airways charges anywhere from 5 to 50 cents per $100

60. Pan American's trans-Pacific express shipments do not often exceed the 200 cu. in. limit. Conversations with H. Brundage, P.A.A., San Francisco office.

valuation of shipment in addition to the regular tariff and insurance costs for its foreign express service.[61]

Common carriers are by law absolute guarantors of the safety of goods in their custody. They can and do to a large extent minimize this obligation by establishing double rates: i. e., the usual one, for which their maximum liability per shipment is limited to a fixed amount such as $50, and a special rate, by which the shipper pays an additional charge and gets full value protection. In the case of R.E.A. on either its rail express, air express or combined rail-air express business the additional charge amounts to 10 cents per $100 valuation up to $25,000 valuation per shipment.[62] This excess charge can be made to reimburse the carrier not only for the extra insurance risk but also for the greater value of the transportation service.[63] Although shippers, by failing to declare full value, could avoid their share of excess value charges, it is a reasonable assumption that most shippers of valuable goods do pay the special rate for full protection. It would seem preferable in the long run to combine any excess value rate-element with the extra insurance charge rather than to complicate further the air freight tariff by separate excess valuation and insurance fees.

D. *Special Classes*

In discussing the subject of the demand for an air freight service and the necessity of keeping the airplane's load factor high, mention was made that specially low rates might be necessary to aid traffic in a particular direction. Thus on a coast-to-coast run lighter loads may be expected in an east-bound direction. To offset this, one or more special classes, similar to those provided for in the Railway Express Tariff, at 60 or 75 per cent of regular rates, could be set up for certain commodities such as cut flowers and tree-ripened fruits. At present, the Air Express Tariff offers special rates of 60 and 75 per cent of regular rates on racing forms and 60 per cent on newspapers.[64] Special rates should, of course, be applied cautiously and be invoked only where it has been demonstrated that the airplane would otherwise not be fully loaded. Actually this service would be offered at less than the cost of operation and be intended only to cut down loss on the less profitable portion of the business.

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61. C.A.A. No. XP-1. This results in the unhappy situation of the shipper's being billed for three separate charges.

62. Air Express Tariff, C.A.A. No. 1, Rules 3 and 12.

63. That the 10 cents per $100 is large enough for this double purpose is a fair inference from the fact that the standard airline trip life insurance rate (four hours) is at the rate of only one-half cent per $100.

64. Air Express Tariff, C.A.A. No. 1, Supplement 3.

E. *Deferred Delivery*

Before leaving the subject of rates, emphasis should be placed upon the importance of a long-distance deferred delivery service at reduced rates. This could be either in conjunction with or in addition to the above Special Classes. By charging a portion of regular rates and undertaking only to deliver in less time than is possible by rail express, the load factor could probably be kept very high and hence the operations made extremely efficient. Possibly a discount which fluctuated from season to season from 75 to 50 per cent, as operations warranted, would be practicable. On a coast-to-coast service, a 50 per cent reduction in the previously suggested rates would make many of them just slightly higher than or equal to those of rail express. With the assurance that goods would be delivered at least one or two days sooner than the rail express time of delivery, many long-distance shippers would be glad to take advantage of a deferred delivery service. The air freight carrier would be able to draw upon accumulated deferred delivery shipments to fill out unused space or load and thus improve the efficiency and profits of its operations.

One may cite here the amazing growth of Transportes Aereos Centro-Americanos Ltd.'s freight operations, due in large measure to a low-rate, deferred delivery service.[65] This one company handles in six months as much commodity traffic as do all the airlines of the United States in a year. The time advantage of long-distance air freight over rail express in the United States, although by no means so great as that of TACA over Honduran mules, is nevertheless considerable. The amount of industrial traffic in the United States that waits to be tapped by an air freight service with rates approximating those of rail express is so vast as to make the situation here almost as attractive as that in Central America.

The foregoing suggested general provisions, relating to the basic rates, space, value, special classes and deferred delivery, are presented in the air freight tariff shown in Appendix III.

PROFITS

The development of an air freight service involves so many assumptions and variable factors of importance that a discreet silence on this subject might seem advisable. But if private capital is to have the responsibility of creating this new industry, it must first be shown that the business would be profitable.

Throughout this study, assumptions have had to be made or

65. H. B. Deutsch, *Saturday Evening Post*, December 3, 1938.

borrowed regarding matters for which concrete data or information was unobtainable. Since each one has a significant bearing on the question of profits, it seems fair to summarize at this time the more important of them. 1) At rates two or three times those of rail express, the demand for air freight service would be very great, with shipments averaging 15 pounds and 1,250 miles. 2) The airplanes used would be of the same general type and operating efficiency as the Boeing 247-D, and, in the case of a new airline, sufficient aircraft would be available to enable operations on as large a scale as those of United Air Lines in 1936.[66] 3) The Railway Express Agency would cooperate with the freight airlines as it now does with passenger airlines but on the basis of 80 cents per pick-up and delivery (up to 40 pounds). 4) The load factor would average 75 per cent.

The above assumptions, as well as the various data and material referred to throughout this study, justify an opinion that large profits may be expected in the operation of a long-distance air freight business. In the study of costs, the expenses of operation, exclusive of interest on capital investment, were found to total .0136 cents a pound-mile. In the consideration of a suitable rate structure a tariff was suggested that, in the classifications where business was expected, averaged about .015 cents a pound-mile. This indicates a profit of about .0014 cents a pound-mile. Total operating profit would depend upon the number of revenue-miles flown. The cost of interest on capital investment would be an additional consideration in the case of a new airline. But, whether new air freight company or established airline, an appreciable annual profit is indicated.[67]

The purpose of this section was not so much to demonstrate how great profit could be made in the air freight business as to show that ultimately this phase of air transportation may become one of the nation's most profitable industries. It was intended, also, to point out that established major airlines are in a very favor-

66. In the case of a new airline, freight revenue miles equal to those of U.A.L. in 1936, calling for 36 freight airplanes (*cf.* Table 5), have previously been assumed to enable operating costs similar to those of an existing major airline. To the extent that ground costs decrease with flying costs and that the profits indicated for a new airline in the following footnote may be sacrificed, a lesser number of Boeing 247-D's Lockheed Electras and Douglas DC-2's would be required.

67. On a single daily round-trip transcontinental schedule, such as that suggested in Appendix V, 2,263,000 revenue-miles would be flown annually. With an average payload of 4,560 pounds, business would amount to 5,152,858 ton-miles, for a total profit of approximately $144,000. This is the indicated annual profit of an existing major airline for each transcontinental schedule, involving only five or six obsolete Boeing 247-D's, Lockheed Electras or Douglas DC-2's. A new airline would have to operate a larger number of freight schedules, calling for interest on a large capital investment. Assuming half the capital listed in Table 5 were borrowed at six per cent and seven daily round-trip schedules such as that suggested in Appendix V were made, the profit per round-mile would be .013 cents, and the total annual profit about $937,000. The 36,000,000 ton-miles of air freight traffic envisaged by the latter business is a striking amount, but it is well within the 50,000,000 ton-miles of air commodity traffic forecast many years ago by Mr. Warner (*cf.* p. 457) as possible with low rates.

able position to experiment with and develop this service, A new air transport company should not expect to succeed in this sort of enterprise without entering upon it on a grand scale and risking a large amount of capital.

IV. Routes and Schedules

No study of the practicability of long-distance air freight in the United States is complete without consideration of the subject of routes and schedules. These will be discussed briefly and separately below.

Routes

It has been shown that the demand for air freight service is greatest between remote portions of the country, where the time saving advantage of air transportation over surface facilities can be counted in days. We have seen, too, that there is a great advantage in selecting a route which connects as many prosperous, populous communities as possible—especially cities of great industrial importance. Stops at such centers increase the opportunity of picking up business and enable more frequent refuelings, thus reducing the amount of payload that must be sacrificed to dead load, and permitting a more discreet apportionment of piloting time among the flying personnel.

The present long-distance air routes, although intended primarily for passenger and mail needs, offer satisfactory paths for air freight operations. Such routes present a series of existing airports, intermediate emergency landing fields and conveniently located alternate airports, all with adequate facilities for large airplanes. Established airways are properly maintained, usually by the federal government, with necessary avigational aids, the expense of supplying which would be prohibitive to almost any private airline. When fully developed, an air freight system would doubtlessly supplement that of air express throughout the entire country and in that connection would make use of all important airways. For a beginning, however, development of air freight along the nation's present chief long-distance routes is advisable.

Routes are sometimes classified as either primary, of major traffic importance, or secondary, of minor traffic importance.[68] Although opinion may differ as to the helpfulness of this distinction, the terms are used here to emphasize that operation over some routes, i. e., primary, would be entirely independent of operation on other routes.

68. This distinction appeared in the Air Mail Law of 1934, Par. 8123, Sec. 2d.

Figure 2 shows five primary and one secondary routes. The first four are transcontinental and have been suggested by the present routes of: 1) Northwest Airlines, Inc. and American Airlines, Inc.; 2) United Air Lines;[69] 3) Transcontinental and Western Air, Inc.; 4) American Airlines, Inc., respectively.[70] The fifth and shortest primary route is based on that of Eastern Air Lines from Brownsville, Texas to New York; its importance lies in connecting the eastern seaboard with the industrial south. The route from Brownsville, Texas to Chicago, based on Braniff Airways' present system, is a most important secondary line since it ties together all five primary services and traverses nearly the entire center portion of the country from north to south. In each case slight changes from existing itineraries have been made, either to include additional stops of importance or to reduce the distance between stops.

SCHEDULES

Few aspects of air transportation are more subject to continual experimentation and change than are schedules. Few aspects are more important. Quantity and nature of traffic demand, kind and amount of equipment and weather are all important factors which must be considered. To the extent that performance can be controlled and systematized, a detailed time-table is of utmost importance in achieving punctuality and reliability of service.

As an example of what kind of service a freight airline may be expected to offer with an average flying speed one-third less than that of passenger service, Appendix V provides a time schedule for the previously suggested Primary Route No. 2. Allowing ample time for ground maneuvering at each airport,[71] for loading and unloading,[72] for refueling[73] and for maintaining an average ground speed of about two-thirds that of United Air Lines in 1936, viz., 102 miles per hour westbound and 121.3 miles per hour eastbound, the suggested schedule shows a transcontinental service of approximately 34 flying hours. By arranging a departure from each terminus at 9 or 10 o'clock in the evening, making possible an early arrival at the other terminus on the second day thereafter, a trip

69. An alternate route is shown between Omaha and Cheyenne for Route 2, which could be effected advantageously after traffic developed sufficiently to justify two schedules each way daily or by the shuttle service discussed on p. 478.

70. Of interest are the populations (1930 census) per mile of each route: 2,945, 6,235, 4,557, 5,001, respectively. For the 5th primary route population per mile is 5,936; for the secondary route is 2,689.

71. Lockheed Aircraft Corp. in its exhaustive analysis "Operating Costs," May 21, 1937, allows 7 minutes' maneuvering time between stops. 8 minutes are allowed in the suggested schedule here.

72. From 5 to 15 minutes are ordinarily necessary per stop in passenger service. 10 minutes are allowed in the suggested schedule.

73. The relatively small gasoline requirements would enable quick refueling by trucks capable of pumping gasoline at the rate of 50 gallons per minute.

can be made with the loss of but one working day to the shipper. Between New York and Chicago this arrangement provides a very satisfactory overnight service as well. Industrial people, who, as previously shown, may be expected to form the largest class of shippers, could be offered transportation that would be but slightly slower than air express (from the viewpoint of working days lost) and three times as fast as rail express.

Until operation can be had with safety in practically any kind of weather, air transportation must continue to be somewhat handicapped in competition with ground transportation. Facilities are being installed at many major airports for landings entirely by instrument. But until these improvements are perfected, air transportation must continue to make use of surface conveyance when adverse weather conditions make flights unsafe. Considering the progress of the past few years, it is reasonable to believe that before long reliability of air schedules will fairly closely approach that of surface transportation.

Conclusion

Based upon the foregoing study of the feasibility of air freight operations within the United States, the following conclusions may be upheld with a high degree of confidence. A very substantial demand for rapid and cheap transportation by air of heavy bulky goods is latent, particularly over long distances and between industrial centers of large population. The types of commodities that are likely to be shipped by an air freight service are: dry goods, mechanical parts and supplies, printed matter, perishable foods and cut flowers. The first three classes may be expected to move mostly from the large industrial centers of the east westward, or from north to south, and the last two classes in the opposite directions.

It seems reasonably certain that by various economies, such as use of sound but obsolete passenger equipment, slow flying speed, frequent stops and complete divorcement from the high cost of passenger service, operating expenses of either an existing or future major airline would permit rates which should attract a large amount of traffic. Not only would special governmental financial assistance be entirely unnecessary, but operations on a profitable scale may reasonably be expected.

Just one hundred years ago, when the railroad business was still a puny, struggling enterprise, an obscure business man by the name of W. F. Harnden conceived the idea of employing this then newest and speediest means of transportation for the rapid shipment of "small packages, goods and bundles" between New York

and Boston. People, who knew better, smiled. At first Mr. Harnden was able to carry all shipments in his carpet-bag. Now that carpet-bag service has developed into a nation-wide business each year handling over 140,000,000 shipments, yielding about $150,000,000 in revenues and employing directly more than 57,000 persons. The enterprise is known as the Railway Express Agency.

Reference to this phase of transportation history seems quite in place, because aviation, in some of its branches, shows promise of duplicating the mighty growth of the railroads. Free of the staggering burden of maintaining expensive roads, rights-of-way and ponderous equipment, the airplane may yet prove inherently less costly to operate over long distances than any type of surface transportation vehicle. Shipment of goods by air may indeed become an activity of so vast proportions as to have an important effect on the rate and direction of social progress itself. Whether or not it ever attains this degree of importance and usefulness, a careful consideration of the facts available indicates that the development of a profitable unsubsidized air freight service in the United States today is an entirely feasible proposition.

APPENDIX I

Domestic Air Express Charges (In Cents)*

Distance Zones**

POUNDS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1¼	100	100	100	100	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	120
1½	100	100	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132	134	136	138	140	144
1¾	100	100	102	105	108	111	114	117	120	123	126	129	132	135	138	141	144	147	150	153	156	159	162	168
2	100	100	104	108	112	116	120	124	128	132	136	140	144	148	152	156	160	164	168	172	176	180	184	192
2¼	100	101	106	111	116	121	126	131	136	141	146	151	156	161	166	171	176	181	186	191	196	201	207	216
2½	100	102	108	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	230	240
2¾	100	103	110	117	124	131	138	145	152	159	166	173	180	187	194	201	208	215	222	229	236	243	253	264
3	100	104	112	120	128	136	144	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	276	288
3¼	100	105	114	123	132	141	150	159	168	177	186	195	204	213	222	231	240	249	258	267	276	286	299	312
3½	100	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296	308	322	336
3¾	100	107	118	129	140	151	162	173	184	195	206	217	228	239	250	261	272	283	294	305	316	330	345	360
4	100	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312	324	336	352	368	384
4¼	100	109	122	135	148	161	174	187	200	213	226	239	252	265	278	291	304	317	330	343	357	374	391	408
4½	100	110	124	138	152	166	180	194	208	222	236	250	264	278	292	306	320	334	348	362	378	396	414	432
4¾	100	111	126	141	156	171	186	201	216	231	246	261	276	291	306	321	336	351	366	381	399	418	437	456
5	100	112	128	144	160	176	192	208	224	240	256	272	288	304	320	336	352	368	384	400	420	440	460	480
5½	100	114	132	150	168	186	204	222	240	258	276	294	312	330	348	366	384	402	420	440	462	484	506	528
6	100	116	136	156	176	196	216	236	256	276	296	316	336	356	376	396	416	436	456	480	504	528	552	576
6½	100	118	140	162	184	206	228	250	272	294	316	338	360	382	404	426	448	470	494	520	546	572	598	624
7	100	120	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480	504	532	560	588	616	644	672
7½	100	122	148	174	200	226	252	278	304	330	356	382	408	434	460	486	512	540	570	600	630	660	690	720
8	100	124	152	180	208	236	264	292	320	348	376	404	432	460	488	516	544	576	608	640	672	704	736	768
8½	100	126	156	186	216	246	276	306	336	366	396	426	456	486	516	546	578	612	646	680	714	748	782	816
9	100	128	160	192	224	256	288	320	352	384	416	448	480	512	544	576	612	648	684	720	756	792	828	864
9½	100	130	164	198	232	266	300	334	368	402	436	470	504	538	572	608	646	684	722	760	798	836	874	912
10	100	132	168	204	240	276	312	348	384	420	456	492	528	564	600	640	680	720	760	800	840	880	920	960
11	100	136	176	216	256	296	336	376	416	456	496	536	576	616	660	704	748	792	836	880	924	968	1012	1056
12	100	140	184	228	272	316	360	404	448	492	536	580	624	672	720	768	816	864	912	960	1008	1056	1104	1152
13	100	144	192	240	288	336	384	432	480	528	576	624	676	728	780	832	884	936	988	1040	1092	1144	1196	1248
14	100	148	200	252	304	356	408	460	512	564	616	672	728	784	840	896	952	1008	1064	1120	1176	1232	1288	1344
15	100	152	208	264	320	376	432	488	544	600	660	720	780	840	900	960	1020	1080	1140	1200	1260	1320	1380	1440
16	100	156	216	276	336	396	456	516	576	640	704	768	832	896	960	1024	1088	1152	1216	1280	1344	1408	1472	1536
17	100	160	224	288	352	416	480	544	612	680	748	816	884	952	1020	1088	1156	1224	1292	1360	1428	1496	1564	1632
18	100	164	232	300	368	436	504	576	648	720	792	864	936	1008	1080	1152	1224	1296	1368	1440	1512	1584	1656	1728
19	100	168	240	312	384	456	532	608	684	760	836	912	988	1064	1140	1216	1292	1368	1444	1520	1596	1672	1748	1824
20	100	172	248	324	400	480	560	640	720	800	880	960	1040	1120	1200	1280	1360	1440	1520	1600	1680	1760	1840	1920
21	100	176	256	336	420	504	588	672	756	840	924	1008	1092	1176	1260	1344	1428	1512	1596	1680	1764	1848	1932	2016
22	100	180	264	352	440	528	616	704	792	880	968	1056	1144	1232	1320	1408	1496	1584	1672	1760	1848	1936	2024	2112
23	100	184	276	368	460	552	644	736	828	920	1012	1104	1196	1288	1380	1472	1564	1656	1748	1840	1932	2024	2116	2208
24	100	192	288	384	480	576	672	768	864	960	1056	1152	1248	1344	1440	1536	1632	1728	1824	1920	2016	2112	2208	2304
25	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Over 25 (per pound)	4c	8c	12c	16c	20c	24c	28c	32c	36c	40c	44c	48c	52c	56c	60c	64c	68c	72c	76c	80c	84c	88c	92c	96c

* From C.A.A. *Air Express Tariff* No. 1.

** First zone 149 miles, each subsequent zone 100 miles, except zone 24 which includes all distances beyond 2,349 miles.

APPENDIX II

AIR EXPRESS POUND-MILE RATES (In Cents)

DISTANCE ZONES**

LBS.*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1.000	.500	.333	.250	.200	.167	.143	.125	.111	.100	.091	.083	.077	.071	.066	.062	.059	.055	.053	.050	.048	.045	.043	.042	.040	.038	.037	.035	.034	.033
2	.500	.250	.149	.122	.112	.097	.086	.077	.071	.066	.062	.058	.055	.053	.051	.049	.047	.046	.044	.043	.042	.041	.040	.040	.038	.037	.036	.034	.033	.032
3	.333	.173	.124	.093	.080	.076	.069	.063	.059	.056	.053	.051	.049	.048	.046	.045	.044	.043	.042	.041	.041	.040	.040	.040	.038	.037	.036	.034	.033	.032
4	.250	.135	.100	.082	.072	.065	.060	.056	.053	.051	.050	.047	.046	.045	.044	.043	.042	.042	.041	.041	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
5	.200	.112	.085	.072	.064	.059	.055	.052	.050	.048	.047	.045	.044	.043	.043	.042	.041	.041	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
6	.167	.097	.076	.065	.059	.054	.051	.049	.048	.046	.045	.044	.043	.042	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
7	.143	.085	.069	.060	.055	.051	.050	.047	.046	.045	.044	.043	.042	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
8	.125	.077	.063	.056	.052	.049	.047	.046	.044	.043	.043	.042	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
9	.111	.071	.059	.053	.050	.047	.046	.044	.043	.043	.042	.041	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
10	.100	.066	.056	.051	.048	.046	.045	.043	.043	.042	.041	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
11	.091	.062	.053	.049	.047	.045	.044	.043	.042	.041	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
12	.083	.058	.051	.047	.045	.044	.043	.042	.041	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
13	.077	.055	.049	.046	.044	.043	.042	.041	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
14	.071	.053	.048	.045	.043	.042	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
15	.066	.051	.046	.044	.042	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
16	.062	.049	.045	.043	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
17	.059	.047	.044	.042	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
18	.055	.046	.043	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
19	.053	.044	.042	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
20	.050	.043	.041	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
21	.048	.042	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
22	.045	.041	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
23	.043	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
24	.042	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032
25 and Over	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.040	.038	.037	.036	.034	.033	.032

* Fractions of pounds omitted in the interest of clarity.

** First zone 149 miles, each subsequent zone 100 miles, except zone 30 which includes all distances beyond 2,949 miles.

APPENDIX III

Suggested Air Freight Tariff Provisions

Basic Rates

	Distance Zones		
Weight	*To* 1000 *miles*	1001-2000 *miles*	2001-3000 *miles*
Up to 10 lbs.	$1.50	$2.50	$3.50
Each lb. over 10 lbs.	.15	.25	.35

Fractions of a pound will be charged for as a full pound.

Space

Packages with cubic measurements exceeding 200 cubic inches per pound will be charged for on the basis of one pound for each 200 cubic inches.

Excess Value (Insurance)

The charges shown herein provide full Common Carrier liability for a valuation not exceeding $50 for packages weighing less than 100 pounds or 50 cents per pound, actual weight, for packages weighing over 100 pounds. When the declared value exceeds $50 for any shipment of 100 pounds or less, or exceeds 50 cents per pound actual weight for any shipment in excess of 100 pounds an additional charge of 10 cents will be assessed for each $100 or fraction thereof in excess of the value stated above and such additional charges provide full Common Carrier liability for the value so declared.

Special Classes

Cut flowers and fresh fruits and vegetables and other specified commodities will be charged for at 60 to 75 per cent of regular charges.

Deferred Delivery

Except commodities mentioned above in Special Classes, transcontinental shipments will be accepted for delivery in one or two days' extra time at 50 to 75 per cent of the basic rates.

APPENDIX IV

Suggested Air Freight Pound-Mile Rates
(In Cents)

Distance Zones*

LBS.	1	2.	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1.500	.750	.500	.375	.300	.250	.214	.187	.166	.150	.228	.208	.192	.179	.167	.156	.147	.139	.132	.125	.166	.159	.152	.146	.140	.135	.130	.125	.121	.117
2	.750	.370	.250	.187	.150	.125	.107	.093	.083	.075	.114	.104	.096	.090	.083	.078	.073	.070	.066	.063	.083	.080	.076	.073	.070	.068	.065	.062	.060	.058
3	.500	.250	.166	.125	.100	.083	.071	.062	.055	.050	.076	.069	.064	.060	.056	.052	.049	.046	.044	.042	.055	.053	.051	.049	.047	.045	.043	.042	.040	.039
4	.375	.187	.125	.093	.075	.063	.053	.044	.042	.037	.057	.052	.048	.045	.042	.039	.037	.035	.033	.031	.042	.040	.038	.036	.035	.034	.032	.031	.030	.029
5	.300	.150	.100	.075	.060	.050	.043	.037	.033	.030	.046	.042	.038	.036	.033	.031	.029	.028	.026	.025	.033	.032	.030	.029	.028	.027	.026	.025	.024	.023
6	.250	.125	.083	.063	.050	.042	.036	.031	.028	.025	.038	.035	.032	.030	.028	.026	.024	.023	.022	.021	.028	.026	.025	.024	.023	.023	.022	.021	.020	.019
7	.214	.107	.071	.053	.043	.036	.031	.027	.024	.021	.033	.030	.028	.026	.024	.022	.021	.021	.019	.018	.024	.023	.022	.021	.020	.019	.019	.018	.017	.017
8	.187	.093	.062	.047	.037	.031	.027	.023	.021	.019	.028	.026	.024	.022	.021	.020	.019	.017	.016	.016	.021	.020	.019	.018	.018	.017	.016	.016	.015	.015
9	.166	.083	.055	.042	.033	.028	.024	.021	.018	.016	.025	.023	.021	.020	.019	.017	.016	.016	.015	.014	.019	.018	.017	.016	.016	.015	.014	.014	.013	.013
10 and Over	.150	.075	.050	.037	.030	.025	.021	.018	.016	.015	.023	.021	.019	.018	.017	.016	.015	.014	.013	.013	.017	.016	.015	.015	.014	.013	.013	.013	.012	.012

* First zone 149 miles, each subsequent zone 100 miles, except zone 30 which includes all distances beyond 2,949 miles.

APPENDIX V

Suggested Air Freight

Coast-to-Coast Time Schedule for Primary Route No. 2

Miles	*Station*	*Local Time*	*Time Zone*	*Local Time*
	NEWARK	lv. 22:00	EST	arr. 07:41
72				
	CAMDEN	arr. 22:50	EST	arr. 06:47
101				
	HARRISBURG	arr. 00:07	EST	arr. 05:39
132				
	PITTSBURGH	arr. 01:43	EST	arr. 04:16
127				
	CLEVELAND	arr. 03:16	EST	arr. 02:53
91				
	DETROIT	arr. 04:28	EST	arr. 01:50
63				
	TOLEDO	arr. 05:23	EST	arr. 01:01
150				
	SOUTH BEND	arr. 06:09	CST	arr. 22:29
79				
	CHICAGO	arr. 07:13	CST	arr. 21:32
200				
	IOWA CITY	arr. 09:29	CST	arr. 19:35
109				
	DES MOINES	arr. 10:51	CST	arr. 18:23
117				
	OMAHA	arr. 12:18	CST	arr. 17:07
53				
	LINCOLN	arr. 13:07	CST	arr. 16:23
178				
	NORTH PLATTE	arr. 15:10	CST	arr. 14:37
238				
	CHEYENNE	arr. 16:48	MST	arr. 11:21
230				
	ROCK SPRINGS	arr. 19:21	MST	arr. 09:09
160				
	SALT LAKE CITY	arr. 21:14	MST	arr. 07:32
220				
	ELKO	arr. 22:41	PST	arr. 04:25
210				
	RENO	arr. 01:02	PST	arr. 02:23
200				
	SAN FRANCISCO	arr. 03:18	PST	arr. 00:26
166				
	FRESNO	arr. 05:14	PST	arr. 22:46
198				
	LOS ANGELES	arr. 07:27	PST	lv. 21:00
3,094	Total	Read Down		Read Up

24 hour clock used.
10 minutes allowed at each stop; 8 minutes for maneuvering between stops.
Average ground speed 102 m.p.h. westbound; 121.3 m.p.h. eastbound.